

## Use of waste plastic coated aggregates in bituminous road construction

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**Abstract:** Now a days, the population growth, industrialization, consumerism and technological development have led to uncontrollable accumulation of waste. Proper waste disposal is of great importance in both rural and urban areas. Many of the wastes produced today will remain in the environment for many years leading to various environmental concerns. Therefore it is necessary to utilize the wastes effectively with technical development in each field. Use of this waste mix for road construction helps to use plastics waste. Once the plastic waste is separated from municipal solid waste, the organic matter can be converted into manure and used. This paper deals with the investigations of the use of waste plastic for coating of aggregates in the bituminous road construction. This paper presents the use of plastic which is collected from municipal solid waste for coating aggregates in bituminous road construction. Marshall properties, impact values, specific gravity, abrasion test, water absorption, soundness and stripping value of the waste plastic coated aggregates were determined.

**Keywords:** Waste plastic; Physical properties; Aggregates; Bitumen.

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### 1. Introduction

Plastics, a versatile material and a friend to common man. Plastic is everywhere in today's lifestyle. In recent years, applications of plastic wastes have been considered in road construction with great interest in many developing countries. The use of these materials in

road making is based on technical, economic, and ecological criteria. Several million metric tons plastic wastes are produced every year in India.

Plastics waste constitutes a significant portion of the total municipal solid waste (MSW) generated in India. However, the end-of-life plastics can be recycled into a second life application but after every thermal treatment, degradation of plastics takes place to a certain extent. To evaluate the performance of the built roads using plastics waste coated aggregate (PCA) bitumen mix and also to generate data base for evolving Standards by Indian Road. [01]

## **2. Theory and Experimental**

Plastic use in road construction is not new. Plastic roads mainly use plastic carry-bags, disposable cups and PET bottles that are collected from garbage dumps as an important ingredient of the construction material.[02] This paper deals with coating process, analysis of properties of plain aggregate and waste plastic coated aggregate sample and its comparison.

The aggregates are bound together either by bituminous materials or by cement. Stone aggregate used for road work should be hard, tough, durable and hydrophobic for bituminous surface. The quantity of aggregates used in first coat of surface dressing should be  $0.15 \text{ m}^3$  per  $10 \text{ m}^2$  area of 12mm nominal size. On the other hand, the quantity of aggregate used in second coat of surface dressing should be  $0.15 \text{ m}^3$  per  $10 \text{ m}^2$  areas and of 10mm nominal size. Aggregate of 20mm, 10 mm are used for making samples [03].

Bitumen is used as binders in pavements constructions. Bitumen may be derived from the residue left by the refinery from naturally occurring asphalt. In most parts of India 80/100 and 180/200 grade bitumen is used.



Fig. 1 Ordinary Aggregates



Fig. 2 Plastic Coated Aggregate



Fig. 3 Bitumen

Heavier grade cut backs, rapid setting emulsions or heavier grade tars may also be used.[4]

### PREPARATION OF POLYMER-AGGREGATE-BITUMEN MIX

Cleaned and dried plastic wastes (e.g.: disposed carry bags, films, cups and thermocol) with a maximum thickness of 60 microns is shredded into small pieces (2.36 mm - 4.75 mm

size). PVC is not suitable for this process [6]. Aggregate is heated to  $165^{\circ}\text{C}$  in a mini hot mix plant. Shredded plastic is added to the hot mix. The plastic gets softened and coated over the surface of the aggregate giving an oily look in 30 - 60 sec. Hot Bitumen (heated up to a maximum of  $160^{\circ}\text{C}$  to ensure good binding) is added immediately and the contents are mixed well [5]. The mix, when cooled to  $110 - 120^{\circ}\text{C}$  can be used for road laying using 8 ton capacity road roller.[03] As the plastics are heated to a maximum temperature of  $165^{\circ}\text{C}$ , there is no evolution of any gas. When heated above  $270^{\circ}\text{C}$ , the plastics get decomposed and above  $750^{\circ}\text{C}$  they get burnt to produce noxious gases.

Following Tests were conducted to investigate the properties of the aggregate as well as bitumen [7]. Specific Gravity Test, Water Absorption Test, Aggregate Impact Value Test, Aggregate Crushing Value, Flakiness, Elongation Index Test, Penetration Test, Ductility Test, Flash Points, marshal stability and Fire Point[8].



Fig. 4 Sample of waste plastic coated aggregate

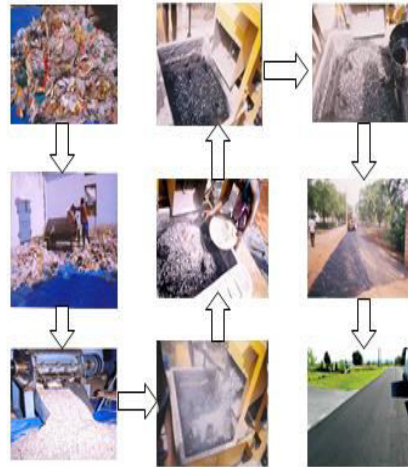


Fig. 5 Preparation of polymer aggregate- bitumen mix

### 3. Results and Discussion

Aggregate was obtained from a local quarry and the physical properties were tested in the laboratory and are given in fig. 6, 7 and 8.

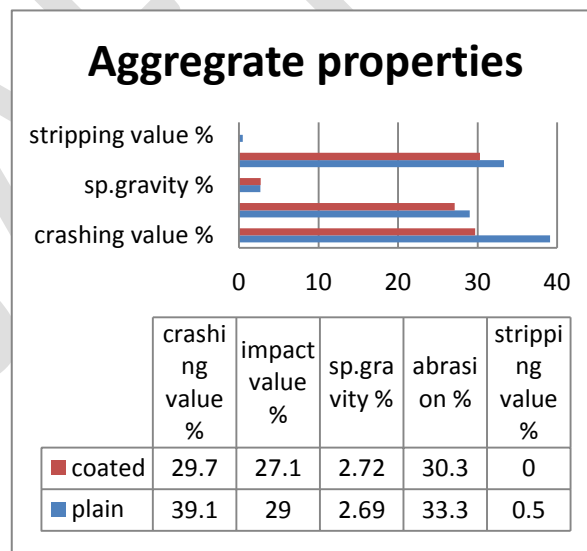


Fig. 6 Aggregate Properties



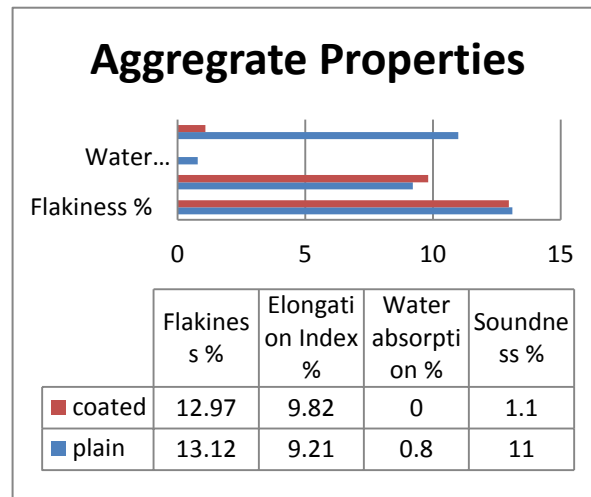


Fig. 7 Aggregate properties

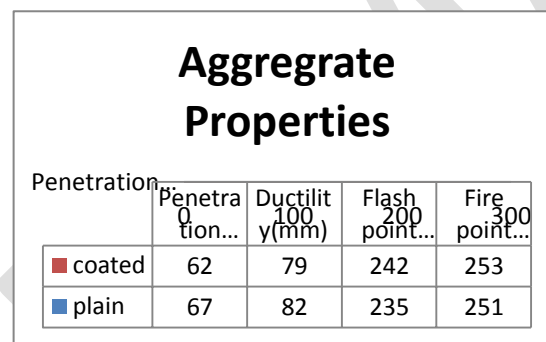


Fig. 8 Aggregate properties

Marshall stability (MS) value increases by using polymer coated aggregate, however, at higher plastic contents it decreases as shown in fig.9. This result may indicate that better adhesion provided between asphalt binder and aggregate particles. Marshall Stability test was conducted for different percentages of bitumen on ordinary aggregate and plastic coated aggregate. The results are shown in Table 4

Bitumen by wt. of mix	Bitumen by wt. of aggregate	Marshall stability value	Marshall stability value (coated)
4	4.2	1205.18	2301.21
4.5	4.7	1480.32	2812.1
5	5.3	1006.31	2188.43

TABLE 4: MARSHALL TEST RESULTS

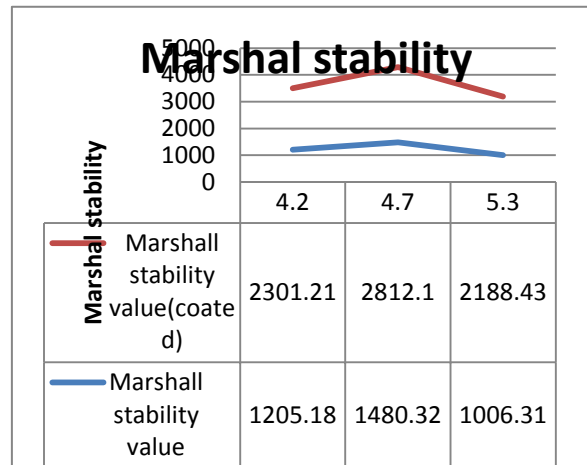


Fig. 9 Marshall Stability test result

The physical properties of plastic coated aggregates are shown in fig. 6, 7 and 8. It is seen that the properties like water absorption, stripping value and soundness are improved using plastic coated aggregate.

The coated aggregate mixture has increased Softening Point and decreased Penetration Value with a suitable ductility. When used for road construction it can withstand higher temperature. Hence it is suitable for tropical regions. It has decreased Penetration Value. Hence its load carrying capacity is increased. The blend with aggregate has no Stripping Value. So it can resist the effect of water.. Disposal of waste plastic will no longer be a problem. The use of waste plastics on the road has helps to provide better place for burying the plastic waste without causing disposal problem. At the same time, a better road is also constructed. It also helps to avoid the general disposal technique of waste plastics namely land-filling and the incineration, which have certain burden on ecology.

#### 4. Conclusions

By using plastics-waste coated aggregate in road construction, helps to

- Use higher percentage of plastic waste
- Reduce the need of bitumen
- Increase the strength and performance of the road

- iv. Avoid the use of anti-stripping agents.
- v. Reduce the cost to around 10%
- vi. Avoid disposal of plastic waste by incineration and land filling
- vii. Add value to plastic waste
- viii. Generate jobs for rag pickers
- ix. Develop a technology, which is eco-friendly

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### **Acknowledgements**



I take this opportunity to thank all the people who have given assistance to us in the form of advice, suggestions, and any other for completion of this paper. It is a pleasure to convey my gratitude to them all in our humble acknowledgment. It is an honour for me to express my sincere gratitude to Dr. M.A.Dabhade for providing all necessary support for completion of this paper. Next, it is my pleasure to acknowledge the various individuals who contributed in completion of my paper. Finally, I am thankful to my family for allowing me to complete this paper in the time.

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